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Matches and Lighters In Flammable Fabric Incidents: The Magnitude of the Problem

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Matches and Lighters In Flammable Fabric Incidents: The Magnitude of the Problem

James A. Slater, Benjamin Buchbinder and Henry Tovey

Matches and lighters were a major factor in the 1,838 flammable fabric incidents studied for which ignition sources are known. They accounted for 430, almost one-fourth, of the ignitions and led to 375 injuries, of which 57 were fatal. Children and the elderly were the groups most frequently involved in fires started by matches or lighters. Nearly half the incidents involved children under age 11, and two-thirds of these were children under age 6. Forty-four of the 57 fatalities were children under age 11 or adults over 65. The highest fatality rate, 57 percent, was experienced by persons over age 65. The home was the predominant location of fires involving matches and lighters. Of the fabric items ignited by matches and lighters, garments were first to ignite four times as frequently as non-apparel items such as furnishings and bedding. Over one-third of the incidents involved intermediary materials in the ignition sequence. Match ignitions outnumbered lighter ignitions by 6 to 1. Among the 430 match and lighter incidents, fires involving children were overwhelmingly the result of playing with matches and lighters, whereas for persons over age 16, smoking was the single most prevalent activity at the time of ignition.

Key words: Fabric fires; FFACTS; fire injuries; flammable fabrics; ignition sources; lighters; matches.

1. Introduction

1.1. The Role of Ignition Sources

The flammability characteristics of fabric products are only one of the contributing causes of fabric fire incidents. An ignition source must also be present; otherwise, there can be no fire. Thus, one way to reduce the frequency of fire incidents would be to design ignition sources in a manner that would minimize the likelihood of starting unwanted fires by accident or by misuse. For this purpose, an effort is under way at the National Bureau of Standards (NBS), in parallel with the development of fabric product flammability standards, to identify those ignition sources which are causally involved in unwanted fabric fires and to characterize the nature of those involvements. This effort hopefully will contribute

to the design of safer ignition sources and thus reduce the level of the fire hazard. This report presents a summary and analysis of information on matches and lighters as ignition sources in fabric fire incidents, derived from the NBS Flammable Fabrics Accident Case and Testing System, a subsystem of the National Fire Hazard and Loss Data System.

1.2. The Flammable Fabrics Accident Case and Testing System

Section 14a of the Flammable Fabrics Act, as revised and amended December 14, 1967, states that the Secretary of Health, Education, and Welfare in cooperation with the Secretary of Commerce shall conduct a continuing study and investigation of deaths, injuries and economic losses resulting from accidental burning of fabric products. In the spirit of this legislative mandate, the two agencies are cooperating to obtain the needed information. Accidental fires involving fabric products are investigated by Food and Drug Administration (FDA) investigators using questionnaires developed in cooperation with the NBS Fire Technology Division (FTD). Reports on these incidents, along with the remains of fabric products involved, are sent to the FTD Information and Data Section for analysis and testing. These incidents are not selected on a statistical basis and they do not, therefore, constitute a statistically representative sample of all fabric fire accidents in the United States. Nevertheless, they represent events investigated without known preference and may be roughly representative of incidents reported to the agencies from which the FDA obtains accident data.

The FTD processes the reports and fabric samples received from FDA, through FFACTS. The procedures under FFACTS include reviewing and screening of incident reports, laboratory testing and characterization of the fabric products involved in the accidents, data encoding, formatting, editing, and entry into a computer master file. Up to 200 data elements are coded for each fire accident case. The encoded data are derived from the incident reports. They include the time and location of the accident, personal and socio-economic facts about the victim, extent of injury and losses, the sequence of events leading to the accident, and the nature of involvement of the fabric product. Data derived from laboratory tests performed on the fabric products' remains are also encoded, including fabric construction and fiber content, and the results of flammability tests.

Data in the computer master file are tabulated and analyzed to provide quantitative information on the relative frequencies of the involvement of different fabric products, as well as on trends and significant interrelationships between parameters. Such information is further analyzed and interpreted to develop candidate priorities for national mandatory standards for the flammability of fabric products, to provide the basis for the development of realistic tests which can discriminate between highly hazardous products and those of lower potential hazard, and to provide insight into various aspects of the flammable fabric

problem. The overall objective of the system is to identify and rank the various ways of reducing the burden of deaths, injuries, and economic losses sustained by the American people from the accidental burning of fabric products.

2. Findings

The findings presented in this report are based on 1,948 fabric fire incidents in FFACTS on September 1, 1972. The source of ignition is known for 1,838 of these incidents. Matches, lighters, smoking materials, kitchen ranges, heaters and open fires constitute the majority of the ignition sources[1]. The following findings concern just two of these ignition sources - matches and lighters - which were responsible for 430 of the 1,838 known ignitions.

2.1. Ignition Sources in Flammable Fabric Incidents

Table 1 classifies the 1,948 separate fire incidents in FFACTS by ignition source category. It also shows the number of incidents in which intermediary materials were involved in the ignition sequence.

Table 1. Ignition Sources for Flammable Fabric Incidents

Ignition Source	Involvement of Intermediary Material			TOTAL
	Yes	No	Unknown	
Matches and Lighters	153	266	11	430
Smoking Materials	15	416	15	446
Kitchen Ranges	54	256	5	315
Heaters	86	74	3	163
Open Fires	112	78	5	195
Electrical Wiring	10	42	5	57
Appliances (other than ranges)	15	35	3	53
Other	107	69	3	179
Total Known	552	1,236	50	1,838
Unknown	42	26	42	110
TOTAL	594	1,262	92	1,948

[1] An earlier report, NBS Report #10629, Ignition Sources in Accident Cases Involving Flammable Fabrics, presented a preliminary summary of the role of ignition sources in FFACTS incidents but was subject to restricted distribution due to its preliminary nature. That report is currently being revised for publication as an NBS Technical Note.

Twenty-three percent of the 1,838 incidents for which the ignition source is known were initiated by matches or lighters. Smoking materials accounted for 24 percent of known ignitions, kitchen ranges were responsible for 17 percent, open fires for 11 percent and heaters for 9 percent. Table 2 shows the involvement of the specific ignition sources in the three major categories identified in table 1.

Intermediary materials are any non-fabric materials, such as flammable liquids, natural gas, or paper, that become involved in the ignition sequence and form a link between an ignition source and a fabric item. Flammable liquids are of particular importance when they impregnate or come in contact with fabrics since this compounds the flammability hazard. The specific role of flammable liquid involvement in match and lighter incidents is treated in sections 2.4 and 2.6.3.

In general, intermediary materials were involved in 552, or 31 percent, of 1,788 incidents for which the extent of intermediary material involvement could be determined and for which the ignition source was known. While only 2 percent of cigarette incidents and 17 percent of range incidents are known to have involved intermediary materials, the corresponding numbers for matches and lighters are 34 percent and 37 percent. Heaters and open fires show an even higher involvement with intermediary materials at 52 and 57 percent, respectively.

Table 2. Major Ignition Sources for Flammable Fabric Incidents

a. Matches and Lighters

Ignition Source	Involvement of Intermediary Material			TOTAL
	Yes	No	Unknown	
Matches	126	233	7	366
Lighters.	22	33	4	59
Unspecified	5	-	-	5
TOTAL	153	266	11	430

b. Smoking Materials

Ignition Source	Involvement of Intermediary Material			TOTAL
	Yes	No	Unknown	
Cigarettes.	8	341	10	359
Cigars/Pipes.	3	10	-	13
Unspecified	4	65	5	74
TOTAL	15	416	15	446

Table 2. (cont.)

c. Kitchen Ranges

Ignition Source	Involvement of Intermediary Material			TOTAL
	Yes	No	Unknown	
Electric.	11	84	2	97
Gas	31	166	3	200
Other	3	-	-	3
Unspecified	9	6	-	15
TOTAL.	54	256	5	315

2.2. Age and Sex of Persons Involved

Table 3 shows the age and sex of all persons involved in match and lighter incidents. The data have been grouped into six age intervals representing "preschool" children ages 0-5, children 6-10, children 11-15, "young adults" ages 16-20, adults ages 21-65, and the "elderly" over age 65. These age groups were devised partly on the basis of apparent behavior patterns and partly for convenience of analysis and reporting. With the exception of the 21-65 age group, each age group represents approximately 10 percent of the U. S. population, as shown in table 4; the 21-65 age group represents about 50 percent of the U. S. population. These age groupings will be used throughout the report. (Note that the figures in table 3 represent "persons involved", whereas the figures in table 2 represent "incidents". These figures need not agree, since more than one person may be involved in a single incident.)

Children under age 6 constituted 32 percent of the 418 persons involved in match and lighter incidents whose ages are known. Children under age 11 represented 45 percent of the total. Of the 135 children under age 6, only 6 were under age two, and in all 6 cases their involvement was due to the actions of other (older) persons.

There seems to be little difference between the sexes for match ignitions in the 0-5 age group, but between the ages of 6 and 20, males were involved in three times as many match incidents as females. For lighter ignitions, males outnumbered females, 17 to 11, in the 0-5 age group. In the over 21 category, male involvement continued to predominate in lighter incidents, whereas the match incidents were fairly evenly divided between male and female involvement, the latter totaling 74 for males and 78 for females.

It is of interest to compare the age distribution of the 418 (age known) persons involved in match and lighter incidents tabulated in FFACTS with the age distribution of the United States as a whole. This comparison is made in table 4. The FFACTS cases are not necessarily representative of national involvement; nevertheless, table 4 shows that the percentage

of children under 6 years of age involved in match and lighter incidents is more than three times their representation in the population of the nation. The entire age group from 11 to 65 represents 44 percent of the persons involved in FFACTS match and lighter incidents, compared to its 70 percent representation in the U. S. population. Percentage differences in the other age groups are too small to be of interest.

Table 3. Age and Sex of Persons Involved in Match and Lighter Incidents

Age	Matches			Lighters			TOTAL
	Male	Female	Total	Male	Female	Total	
0-5	57	50	107	17	11	28	135
6-10	32	17	49	4	2	6	55
11-15	26	5	31	1	-	1	32
16-20	17	2	19	-	-	-	19
21-65	57	60	117	11	5	16	133
Over 65	17	18	35	6	3	9	44
Total Known	206	152	358	39	21	60	418
Unknown	5	2	7	-	-	-	7
TOTAL	211	154	365[a]	39	21	60	425[a]

[a] Fourteen persons involved in match ignited fires are omitted from the table because both age and sex are unknown. The total number of persons actually involved in match ignitions is 379; the number of persons involved in the total of match and lighter ignitions is 439.

Table 4. Age Distributions for Persons (Age Known) Involved In FFACTS Match and Lighter Incidents and for the United States as a Whole

Age	Persons Involved		Percent of Total U. S. Population[a]
	Number	Percent of Total	
0-5	135	32.3	10.3
6-10	55	13.2	10.0
11-15	32	7.7	10.2
16-20	19	4.5	9.1
21-65	133	31.8	50.8
Over 65	44	10.5	9.6
TOTAL	418	100.0	100.0

[a] Derived from 1970 U.S. Bureau of the Census population statistics.

2.3. Location of Incidents

Table 5 shows the general location of the incidents involving matches and lighters, by age of persons involved. More incidents occurred in and around the home than away from home for all age groups. The overall predominance of "home" to "non-home" was four to one. For children under age 6, 126 or 93 percent were involved in home incidents. For the age group 11 to 20, the home, although still the location of the majority of incidents, was the site of only 63 percent of the incidents. This was the lowest level for any age group.

Table 5. General Location of Incidents
By Age of Persons Involved

Age	Home			Non-Home			TOTAL
	Matches	Lighters	Total	Matches	Lighters	Total	
0-5	99	27	126	8	1	9	135
6-10.	38	5	43	11	1	12	55
11-15.	19	1	20	12	-	12	32
16-20.	12	-	12	7	-	7	19
21-65.	94	13	107	23	3	26	133
Over 65. . . .	25	7	32	10	2	12	44
Total Known	287	53	340	71	7	78	418
Unknown. . . .	17	-	17	4	-	4	21
TOTAL . . .	304	53	357	75	7	82	439

The specific location of home fires is detailed in tables 6a and 6b for matches and lighters, respectively. The most prevalent location for match incidents was a bedroom, where 88 or 30 percent of the known incidents occurred. For lighters, the living room was the predominant location, accounting for 38 percent of the incidents for which the specific location was known.

One-third of the match incidents involving children in the 0-5 age group took place in the bedroom. The bedroom was also the most prevalent location of match incidents for ages 16-20 and 21-65, for 6-10 and 11-15 year olds, the yard was the most frequent location with the kitchen a close second.

Over half of the lighter incidents in the home involved children under age 6, 44 percent of the incidents for this age group taking place in the living room, and 26 percent in the bedroom. The number of incidents in specific locations for the other age groups are too small for meaningful analysis.

Table 6. Specific Location of Home Fires
By Age of Persons Involved

a. Match Incidents

Age	Bedroom	Living Room	Den [a]	Kitchen	Yard	Garage	Other	Unknown	TOTAL
0-5.	33	12	4	10	9	3	19	9	99
6-10	4	6	5	1	12	1	9	-	38
11-15	2	-	-	1	10	2	3	1	19
16-20	4	2	-	2	-	1	3	-	12
21-65	32	16	3	18	4	1	18	2	94
Over 65 . . .	2	7	-	6	3	1	6	-	25
Total known	77	43	12	38	38	9	58	12	287
Unknown . . .	11	2	-	2	-	-	-	2	17
TOTAL. . .	88	45	12	40	38	9	58	14	304

[a] Includes recreation rooms.

b. Lighter Incidents

Age	Bedroom	Living Room	Den [a]	Kitchen	Yard	Other	Unknown	TOTAL
0-5.	7	12	2	3	-	1	2	27
6-10	2	1	1	-	1	-	-	5
11-15	1	-	-	-	-	-	-	1
16-20	-	-	-	-	-	-	-	-
21-65	2	4	-	4	-	2	1	13
Over 65 . . .	-	1	-	2	1	1	2	7
TOTAL. . .	12	18	3	9	2	4	5	53

[a] Includes recreation rooms.

2.4. Activities of Persons Involved at Time of Ignition

Playing with matches and lighters and smoking were the reported activities of 63 percent of 418 persons involved in match and lighter incidents. Tables 7a and 7b detail the activities of persons involved, by age category, for match and lighter ignitions.

Playing with matches was the single most common activity of persons involved. Children under age 16 accounted for 149 of 153 people playing with matches and represented 80 percent of all the children under age 16 involved in match incidents. Almost two-thirds of the 149 children are under 6 years of age.

The use of matches for smoking, on the other hand, was completely limited to persons age 16 or older. Smoking was especially hazardous for persons over age 65, 71 percent of whom were involved in match incidents related to smoking.

Persons involved in lighter incidents showed the same activity pattern as persons in match incidents. All 29 persons playing with lighters were under age 11, while all 6 persons smoking at the time of ignition were over age 20.

Table 7. Activities of Persons Involved, By Age

a. Matches and Lighters Considered Separately

Age	Matches				Lighters			
	Playing	Smoking	Other[a]	Total	Playing	Smoking	Other[a]	Total
0-5 . .	92	-	15	107	24	-	4	28
6-10 . .	44	-	5	49	5	-	1	6
11-15 . .	13	-	18	31	-	-	1	1
16-20 . .	2	4	13	19	-	-	-	-
21-65 . .	2	48	67	117	-	4	12	16
Over 65 .	-	25	10	35	-	2	7	9
TOTAL.	153	77	128	358	29	6	25	60

[a] Includes persons whose activities were unknown.

b. Matches and Lighters Combined

Age	Playing	Smoking	Other[a]	TOTAL
0-5	116	-	19	135
6-10	49	-	6	55
11-15	13	-	19	32
16-20	2	4	13	19
21-65	2	52	79	133
Over 65	-	27	17	44
TOTAL.	182	83	153	418

[a] Includes persons whose activities were unknown.

Table 8 summarizes the number of persons under the influence of intoxicants in match and lighter incidents. Alcohol and drugs may have affected the actions of a small number of people involved in match and lighter incidents, but they were not contributing factors in most of the ignitions. Of 383 persons for whom the information was available, 13 were under the influence of alcohol and 5 were under the influence of drugs. Seventeen of these 18 persons were 21 or older. Eleven of those reported to have been intoxicated were smoking at the time of ignition.

Table 8. Persons Under the Influence of Intoxicants

Intoxicant	No. of Persons		TOTAL
	Match Ignitions	Lighter Ignitions	
Alcohol	11	2	13
Drugs	5	-	5
None	312	53	365
Total Known.	328	55	383
Unknown	51	5	56
TOTAL. . . .	379	60	439

A further definition of activity patterns can be obtained by examining the role of intermediary materials in the ignition sequence. As noted previously in section 2.1, intermediary materials were present in 34 percent of the match incidents and 37 percent of the lighter incidents. From tables 9a and 9b it can be seen that, although children under age 6 were the most represented age group in match and lighter incidents, they had the lowest involvement with intermediary materials. All other age groups had a high involvement of intermediary materials. The 0-5 group apparently plays with matches and lighters, usually in the absence of intermediary materials, resulting in direct ignition of fabric items. The 6-10 age group plays with matches and lighters and intermediary materials as well, resulting in a higher proportion of indirect ignitions of fabrics. The involvement of intermediary materials peaks for the age group 11-20 at a level of 80 percent. Generally, the involvement of intermediary materials for persons over age 15 is related to "using" rather than "playing with" matches and lighters.

Table 9. Presence of Intermediary Materials
By Age Group

a. Match Ignitions

Age	Intermediary Material		No Intermediary Material	Unknown	TOTAL
	Flammable Liquid	Other			
0-5.	8	6	91	2	107
6-10	19	3	27	-	49
11-15	21	4	6	-	31
16-20	9	6	4	-	19
21-65	17	32	68	-	117
Over 65	-	6	28	1	35
Total Known.	74	57	224	3	358
Unknown	-	1	17	3	21
TOTAL. . . .	74	58	241	6	379

b. Lighter Ignitions

Age	Intermediary Material		No Intermediary Material	Unknown	TOTAL
	Flammable Liquid	Other			
0-5	1	4	22	1	28
6-10	2	1	3	-	6
11-15	1	-	-	-	1
16-20	-	-	-	-	-
21-65	5	1	9	1	16
Over 65	7	-	1	1	9
TOTAL. . . .	16	6	35	3	60

Tables 10a and 10b show, for persons involved in match and lighter incidents, the specific intermediary materials involved. In all age groups, except the 21-65 group for match-related fires, flammable liquids were present more often than other types of materials. Gasoline and lighter fluid, respectively, were the most common intermediary materials found in match and lighter incidents. The one exception was the 21-65 age group in which gas was the most frequently involved material ignited directly by matches.

Table 10. Specific Intermediary Material Involvement By Age Group

a. Match Ignitions

Age	Gasoline	Lighter Fluid	Other Flamm. Liquid	Gas	Paper Products	Other	TOTAL
0-5.	8	-	-	-	5	1	14
6-10	13	1	5	-	1	2	22
11-15	13	-	8	1	-	3	25
16-20	5	-	4	6	-	-	15
21-65	11	2	4	28	2	2	49
Over 65	-	-	-	4	2	-	6
Total Known.	50	3	21	39	10	8	131
Unknown	-	-	-	-	1	-	1
TOTAL. . . .	50	3	21	39	11	8	132

b. Lighter Ignitions

Age	Gasoline	Lighter Fluid	Gas	Paper Products	Other	TOTAL
0-5 . . .	-	1	-	3	1	5
6-10. . .	-	2	-	-	1	3
11-15. . .	-	1	-	-	-	1
16-20. . .	-	-	-	-	-	-
21-65. . .	2	3	1	-	-	6
Over 65. .	1	6	-	-	-	7
TOTAL .	3	13	1	3	2	22

2.5. Extent of Injury

Fires initiated by matches and lighters involved 439 people, 375 of whom were injured including 57 persons known to have died as a result of the incidents. Twenty-five of these fatalities were persons over age 65, and 19 were children under age 11. The final dispositions of 69 persons injured in these incidents was unknown at the time their cases were investigated; many were still in hospitals. Tables 11a and 11b show the extent of injury by age of persons involved for matches and lighters, respectively.

Excluding the 4 people whose injury status was unknown, 86 percent of the persons involved in match and lighter incidents were injured. The ratio of match victims to lighter victims is approximately equal to the 6:1 ratio of match incidents to lighter incidents. There were 326 match-related injuries compared to 49 lighter-related injuries. All of the people over age 65 were injured. Furthermore, by computing a death-to-injury ratio for each age group, a major distinction can be seen between the over 65 group and all the others. In the over 65 group, 57 percent of the 44 persons injured died. This is over 5 times the corresponding ratios for the other groups (excluding the 16-20 group, which had no deaths).

Table 11. Extent of Injury By Age

a. Matches As Ignition Source

Age	Not Injured	Injured				Unknown Injury Status	Total Involved
		Recovered	Unknown Disposition [a]	Died	Total Injured		
0-5	7	68	21	11	100	-	107
6-10	2	30	11	6	47	-	49
11-15	1	22	5	3	30	-	31
16-20	1	17	1	-	18	-	19
21-65	24	69	17	7	93	-	117
Over 65 . . .	-	10	6	19	35	-	35
Total Known	35	216	61	46	323	-	358
Unknown . . .	14	3	-	-	3	4	21
TOTAL. . .	49	219	61	46	326	4	379

[a] Patient's final disposition not known when case was investigated.

b. Lighters As Ignition Source

Age	Not Injured	Injured				Total Involved
		Recovered	Unknown Disposition [a]	Died	Total Injured	
0-5 . . .	6	16	4	2	22	28
6-10 . . .	-	4	2	-	6	6
11-15 . . .	-	1	-	-	1	1
16-20 . . .	-	-	-	-	-	-
21-65 . . .	5	8	-	3	11	16
Over 65 . .	-	1	2	6	9	9
TOTAL, .	11	30	8	11	49	60

[a] Patient's final disposition not known when case was investigated.

2.6. Relation of Matches and Lighters to Fabric Item Involvement

2.6.1. General Ignition of Fabrics

Because of varying usage patterns, different ignitions sources can be characterized by the types of fabric items that are ignited first in a fire; and conversely, different fabric items are more frequently ignited by one ignition source than by another. Table 12 shows, for each of the ignition sources listed in table 1, the number of garments, bedding and furnishing items that were first to ignite in the 1,948 incidents in FFACTS. It should be mentioned here that prior to late 1970, FDA investigators concentrated almost exclusively on garment fires. As a result, garments are somewhat overrepresented in the FFACTS data. Since that time, however, all fabric fires have been investigated, regardless of the type of fabric item involved, and enough non-garment data have been collected to firmly establish patterns of fabric item involvement for the most common ignition sources. For example, in FFACTS incidents initiated by smoking materials, bedding incidents (166) and furnishings incidents (139) both outnumber incidents involving garments (76).

Table 12. Ignition Sources By First Fabric Item Category Ignited

Ignition Source	First Fabric Item Category Ignited				TOTAL
	Garments	Bedding	Furnishings	Other	
Matches and Lighters	339	47	23	21	430
Smoking Materials	76	166	139	65	446
Kitchen Ranges	281	4	18	12	315
Heaters	132	6	5	20	163
Open Fires	189	1	4	1	195
Electrical Wiring	21	15	16	5	57
Appliances (other than ranges)	23	18	10	2	53
Other	149	13	15	2	179
Total Known	1,210	270	230	128	1,838
Unknown	47	17	24	22	110
TOTAL	1,257	287	254	150	1,948

In general, apparel items, rather than bedding or furnishings, were most frequently the first fabric item ignited. Garments were ignited first in 79 percent of the match and lighter incidents in FFACTS, compared with 89 percent of kitchen range incidents, 81 percent of heater incidents and 97 percent of open fire incidents. Whereas bedding was almost never the first fabric item ignited in range, heater and open fire incidents, bedding ignited first in over 10 percent of the match and lighter incidents. Small children playing with matches in bedrooms accounted for a significant proportion of these incidents.

2.6.2. Match and Lighter Ignitions of Fabrics

Although the general category (garments, bedding or furnishings) of the first fabric item ignited was known for 430 match and lighter incidents, the specific item type (shirts, mattresses, carpet, etc.) first to ignite was known in only 320 incidents (267 for matches and 53 for lighters), as shown in tables 13a and 13b. Sleepwear and street-wear (e.g., pants, shirts, dresses) were the apparel items most frequently ignited first by matches and lighters. For match and lighter cases combined, sleepwear was the first item ignited in almost one-third of the cases. Pajamas and nightgowns were the most common sleepwear items involved, especially with children. In match incidents alone, 50 percent of the persons over age 65, 40 percent of the children under age 6, and 27 percent of the 21-65 year olds were involved in fires in which sleepwear was the first item to ignite.

Shirts and blouses were ignited first in over one-fifth of the match and lighter cases. They have the highest total frequency of occurrence of any of the fabric items involved and rank first or second in the number of persons involved for every age group.

As previously noted, bedding and furnishings represent only a small percentage of fabric items first ignited by matches and lighters. There is no significant number of bedding cases or furnishing cases for any age group except children under age 6. Sixteen children from this group were among the 31 persons involved in match ignitions of bedding while 5 of 7 persons involved in lighter ignitions of bedding were also under age 6. The remaining persons involved in bedding and furnishings ignitions were scattered throughout the other age groups.

Table 13. First Fabric Item Ignited[a] By Age of Persons Involved[b]

a. Matches As Ignition Source

Item Type	Age							TOTAL
	0-5	6-10	11-15	16-20	21-65	Over 65	Unknown	
Pajamas	25	4	-	1	8	6	-	44
Nightgowns	8	5	-	-	8	4	-	25
Robes/Housecoats	3	2	-	-	6	2	1	14
Other Sleepwear	-	-	-	-	-	1	-	1
Pants/Shorts	4	4	4	2	4	2	-	20
Dresses/Skirts	8	4	-	-	8	4	-	24
Shirts/Blouses	9	10	5	5	21	4	4	58
Outerwear	3	-	1	-	1	-	-	5
Underwear	4	3	4	1	3	1	-	16
Bedspreads/Quilts	6	1	-	-	1	-	-	8
Blankets	5	-	-	-	3	-	-	8
Mattresses/Pads	3	-	1	-	6	-	-	10
Other Bedding	2	-	-	1	1	1	-	5
Drapes	1	-	-	-	4	-	1	6
Carpets/Rugs	1	2	-	-	1	-	-	4
Upholstery	1	-	-	-	2	-	-	3
Other Furnishings	1	-	-	-	1	-	1	3
Other	6	-	1	-	4	1	1	13
TOTAL	90	35	16	10	82	26	8	267

a/ Includes persons involved in only those incidents for which the order of ignition is known and for which the first fabric item ignited can be identified. The numbers in tables 12 and 13 do not agree because in some incidents the particular item first ignited cannot be determined, although its general classification as garment, bedding or furnishing can be.

b/ Includes 5 incidents which involved two persons each. In one of these, two fabric items were listed as first to ignite by the investigator; in the other four, one item was given as first to ignite.

Table 13. (cont.)

b. Lighters As Ignition Source [a]

Item Type	Age						TOTAL
	0-5	6-10	11-15	16-20	21-65	Over 65	
Pajamas.	7	1	-	-	-	2	10
Nightgowns	2	1	-	-	-	-	3
Robes/Housecoats .	1	1	-	-	2	2	6
Pants/Shorts . . .	-	-	-	-	1	-	1
Dresses/Skirts . .	2	-	-	-	-	1	3
Shirts/Blouses . .	2	1	1	-	5	1	10
Outerwear.	1	-	-	-	-	-	1
Underwear.	2	2	-	-	1	-	5
Bedspreads	2	-	-	-	1	-	3
Mattresses/Pads. .	3	-	-	-	1	-	4
Carpets/Rugs . . .	1	-	-	-	1	-	2
Other Furnishings.	3	-	-	-	1	-	4
Other.	1	-	-	-	-	-	1
TOTAL	27	6	1	0	13	6	53

[a] Includes one incident which involved two persons but only one item was given as first to ignite. See also footnote a under table 13a.

2.6.3. Flammable Liquid Involvement

Further complicating the interaction of ignition sources with fabric items is the impregnation of some of the fabrics with flammable liquids at the time of ignition. Whether or not a fabric item was soaked with or was in contact with flammable liquids obviously has a direct bearing on the potential ignition and flammability hazards. Accordingly, the presence or absence of flammable liquids in the first fabric items ignited was ascertained definitely in 52 lighter incidents and 250 match incidents. The results are shown in tables 14a and 14b. Twelve percent of the match ignitions and 21 percent of the lighter ignitions (for which the involvement of flammable liquids was determined) involved fabric items in contact with flammable liquids. All but one of these were garments. Pants, shirts and blouses were involved in 19 of the 29 match incidents in which flammable liquids were involved.

Table 14. Flammable Liquid Involvement
By First Fabric Item Ignited

a. Matches As Ignition Source

Item Type	Flammable Liquids	No Flammable Liquids	Unknown	TOTAL
Pajamas	-	43	-	43
Nightgowns	1	24	-	25
Robes/Housecoats	-	14	-	14
Pants/Shorts	7	12	1	20
Dresses/Skirts	3	21	-	24
Shirts/Blouses	12	40	6	58
Outerwear	1	4	1	6
Underwear	3	9	4	16
Bedspreads/Quilts	-	7	-	7
Blankets	-	6	-	6
Mattresses/Pads	-	10	-	10
Other Bedding	-	5	-	5
Drapes	-	5	-	5
Carpets/Rugs	-	4	-	4
Upholstery	-	3	-	3
Other Furnishings	1	2	-	3
Other	1	12	-	13
TOTAL	29	221	12	262

Table 14. (cont.)

b. Lighters As Ignition Source

Item Type	Flammable Liquids	No Flammable Liquid	Unknown	TOTAL
Pajamas.	3	6	1	10
Nightgowns	-	3	-	3
Robes/Housecoats .	3	3	-	6
Pants/Shorts . . .	1	-	-	1
Dresses/Skirts . .	1	2	-	3
Shirts/Blouses . .	2	6	2	10
Outerwear.	-	1	-	1
Underwear.	1	4	-	5
Bedspreads/Quilts.	-	3	-	3
Mattresses/Pads. .	-	4	-	4
Other Bedding. . .	-	3	-	3
Carpets/Rugs . . .	-	2	-	2
Other Furnishings.	-	3	-	3
Other.	-	1	-	1
TOTAL	11	41	3	55

3. Conclusions and Recommendations

Matches and lighters played a major part in the ignitions of fabric products in fire incidents reported to the NBS Flammable Fabrics Accident Case and Testing System. Almost one-fourth of 1,838 incidents in which the ignition source was known were initiated by a match or a lighter. Only smoking materials (other than matches or lighters) were responsible for as high a proportion of ignitions. Matches alone started fabric fires more frequently than any other single ignition source in the data base, and were involved in six times the number of incidents that lighters were.

The single most significant factor in the match and lighter incidents was the involvement of children. Children under age eleven accounted for 45 percent, almost half, of the 418 persons involved in these incidents. Over two-thirds of these children were under the age of six. The fact that the 45 percent involvement is over twice the representation of children 0-10 years old in the U.S. population and

the fact that the accident cases have been investigated by the FDA without known prejudice give these figures credibility as an indication of the magnitude of the problem.

The general circumstances surrounding match and lighter incidents can be classified by the behavior patterns associated with the age groups involved. The high involvement of children is related to the fact that playing with matches and lighters was a frequent activity of persons involved. Of 153 people playing with matches, 149 were under age 16, and two-thirds of these were under age 6. From the data it appears that there is, as might be expected, an age prior to which children are not involved in match or lighter fires by their own actions. Only 6 children under age 2 were involved in match or lighter incidents, and these incidents resulted from the actions of older persons. This probably relates to, among other things, a lack of mobility, strength, manual dexterity, and initiative and an inability to reach matches and lighters in high places. By the age of 2 or 3 however, children apparently have the ability to strike matches and light lighters, as evidenced by the fact that 28 of the 60 persons involved in lighter incidents were under age 6. The incidence of ignitions was highest for ages 0-5, less for ages 6-10 and less yet for ages 11-15, though still involving large numbers of children. The youngest children have the least comprehension and awareness of the fire hazard posed by matches and lighters, and are the most susceptible to accidents.

An inverse relationship seems to exist between the number of incidents occurring in homes and the ages of children involved, reflecting perhaps the increasing independence of children with increasing age. Home ignitions for the three age groups 0-5, 6-10 and 11-20 decreased substantially from 93 percent to 78 percent to 63 percent, respectively, probably indicating descreasing time spent at home. The change in the specific location of home ignitions from predominantly bedroom and living room for children under 6 to the yard for 6-15 year olds is further evidence of this pattern. The trend toward non-home fires was not maintained by adults, however. Home ignitions rose to 80 percent for 21-65 year olds and then dropped slightly to 73 percent for persons over 65.

Lighter incidents seem to be particularly connected with homes, more so than matches. The ratio of home to non-home incidents for lighters was 7 to 1 while the corresponding ratio for matches was about 4 to 1. This is largely due to the high proportion of children under age 6 involved in lighter incidents in the home (27 out of 60), compared to the corresponding proportion for match incidents (99 out of 379); the proportions of match and lighter ignitions in homes being fairly equal for persons over age 5.

Between the ages of 11 and 15, there was a change from "playing" with matches (or lighters) to "using" matches (or lighters) as the most common activity of persons involved in the incidents reported. Smoking was the single most prevalent activity of people over age 16 and especially for the over 65 age group.

Involvement of intermediary materials in the ignition sequence, relatively unimportant in incidents involving 0-5 year olds, became very significant above age 5. Since playing with matches and lighters was the predominant activity of both 0-5 and 6-10 year olds, intermediary material involvement in the ignition sequences was the major difference between the two. Incidents involving children of ages 0-5 were generally the result of direct contact of a match or lighter with a fabric product. Children ages 6-10 introduced an additional element into the sequence; many of them directly ignited an intermediary material which then ignited a fabric item. Intermediary materials were involved in 45 percent of the match ignitions for 6-10 year olds and only 13 percent of match ignitions for 0-5 year olds. The role of intermediary materials was most pronounced for the 11-20 age group, with 41 out of 51 incidents involving such materials. The ignition of intermediary materials by adults was almost always in the context of "using" a match or a lighter for some specific purpose such as lighting an oven or a cigarette. Lighter fluid was the intermediary material in 13 of 22 lighter cases which involved such materials. Significantly, 6 out of 7 cases involving persons over age 65 involved ignition of lighter fluid as an intermediary stage in the ignition sequence.

Considering the methods of striking a match or lighting a lighter, it perhaps seems logical that the user's garments should be most likely to ignite first due to their proximity to the ignition source. The data bear this out in 79 percent of the match and lighter incidents. Shirts and blouses, being the apparel items initially closest to the flame, were generally the items ignited first. For children under age 6 and adults over age 65, sleepwear was most often ignited first in match incidents. This is again probably due to the living patterns of these two groups and indicates more time spent wearing sleepwear than other age groups.

On the basis of these findings, two courses of action are recommended with the goal of reducing the hazards associated with matches and lighters, namely, redesign and education.

The redesign of matches and lighters to make them more difficult to light is a possible partial solution to the problem. This effort would be aimed at children between ages 2 and 6, who are undoubtedly the biggest problem group. Their motor coordination and dexterity are not yet well developed, and their patience and attention span are short. Based on these physical limitations, it should be possible to design matches and lighters so that many of these children would not be able to light them, or would at least be thwarted in their initial attempts and perhaps lose interest.

Since almost half the persons involved in the match and lighter incidents are children under age 11, with a majority of these under age 6, educational programs may not be very effective if aimed at the victims directly.

An education program directed specifically at parents of children in these age groups might be more effective, however. These parents could be reached through nursery and public school parent-teacher associations and similar organizations. It should be pointed out to them that their children constitute an extremely high risk group with regard to match and lighter fires.

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Matches and lighters were a major factor in the 1,838 flammable fabric incidents studied for which ignition sources are known. They accounted for 430, almost one-fourth, of the ignitions and led to 375 injuries, of which 57 were fatal. Children and the elderly were the groups most frequently involved in fires started by matches or lighters. Nearly half the incidents involved children under age 11, and two-thirds of these were children under age 6. Forty-four of the 57 fatalities were children under age 11 or adults over 65. The highest fatality rate, 57 percent, was experienced by persons over age 65. The home was the predominant location of fires involving matches and lighters. Of the fabric items ignited by matches and lighters, garments were first to ignite four times as frequently as non-apparel items such as furnishings and bedding. Over one-third of the incidents involved intermediary materials in the ignition sequence. Match ignitions outnumbered lighter ignitions by 6 to 1. Among the 430 match and lighter incidents, fires involving children were overwhelmingly the result of playing with matches and lighters, whereas for persons over age 16, smoking was the single most prevalent activity at the time of ignition.

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